detent shown in the drawing to fall; this closes the circuit, and a hook attracted by the coil, catches a tooth cut in the escape-wheel, and holds it till the standard clock reaches the hour. At the hour the standard clock, Fig. 10, allows the lower detent to fall, and so breaks the circuit. Consequently the clock, Fig. 11, starts off side by side with the standard.

Mr. Ritchie, to whom we have referred before, has also devised a plan for correcting clocks by hourly currents. His clock, to be corrected in like manner, gains some second or two per hour. Fifteen seconds before each hour the lever D B (see Fig. 12) is attracted by the electro-magnet A, and a pin in the arm D would thereupon enter and catch a tooth of the escape-wheel, did the disc M allow the other arm of the lever E to move. When the hand reaches the hour, E falls, then D catches S and holds it till the cessation of the current at the sixtieth second of the governing clock.

Generally the use of a long telegraphic wire can only be commanded for a few minutes daily. Fig. 13 shows a very suitable arrangement to be adopted when this is the case. By means of the 24-hour disc the line wire is held in communication with the telegraph office until a few minutes before the clock current is going to be despatched. The notch in the 24-hour disc will at last allow the system of levers to fall, but then the 1-hour disc supports them until about one minute before the clock current is coming; so that, till then, the line is being used for messages. The line wire has not been allowed to fall into circuit with the battery wire; this is still prevented by the 1-minute disc. At the sixtieth second precisely the 1-minute disc allows the line wire to join the battery wire, and out goes the clock current. Some seconds afterwards the 1-hour disc lifts the line wire back into communication with the telegraph office, where it stays for another twenty-four hours.

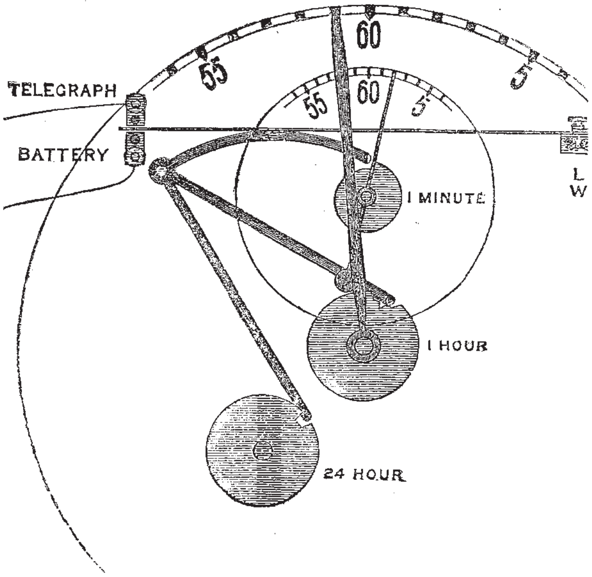

Fig. 13.

The Great Westminster Clock reports its own time to Greenwich by the following arrangement:—Some minutes before a signal is due, a lever is lifted by a slow wheel into such a position that a pin in the next wheel at its coming rotation will catch it. The second wheel lifts it so much further that a pin in the escape wheel reaches it, presses two slight springs together, and sends off the signal.

A method of driving an electric dial was contrived by the late E. J. Dent. A powerful magnet was lifted through a coil of insulated wire by a strong tower clock movement. Every half minute the magnet was dropped a current was generated in the coil, which proceeded to the dial and moved the hands. A plan on the same principle has lately been used for driving a number of small dials. A pendulum having a hollow coil of insulated wire for a bob, is by a heavy weight kept oscillating over a system of magnets. Currents are generated in the coil which proceed to the dials and work them.

Only the principal inventions in electrical clocks and clock-work have been indicated in this article. Since the year 1843 upwards of thirty patents have been applied for for improvements in such clocks and clockwork. It will be seen from this the subject, though not a wide one, is extensive.

Mr. Ritchie kindly lent diagrams 5, 6, 9, 12, and 13 to illustrate his plans, and M. Collin 10 and 11. Figs. 1 and 3 have been arranged to exhibit their working with clearness.

HENRY DENT GARDNER

TAUNTON COLLEGE SCHOOL

WE are sorry to chronicle the extinction of a school once watched with interest by all supporters of scientific education. The company which formed it is insolvent; the school buildings with the fine library and all the collections and apparatus which the late head-master amassed will be sold for the benefit of the creditors; the shareholders will lose their money; and the town will fall back for its higher education on the old, dilapidated, unhealthy grammar school.

The directors of the company, who constituted the council of the school, have performed no ordinary feat. Four years ago the school was nearly full, its annual profits considerable, its distinctions, and consequent reputation, unprecedented in so young an institution; public lectures in literature and science attracted to its hall large classes from the town and neighbourhood; and its systematic teaching of science to all its pupils was studied and imitated by many other schools. The council exhibited sudden activity; they starved the teaching-staff, interfered with the discipline and management, thwarted, harassed, humiliated the head-master. Warnings from parents and old pupils fell upon them unheeded. The last term of 1877 saw two open scholarships at Oxford, two places in Cooper's Hill, and a host of minor honours gained by the boys; but it saw also the head-master bullied into resignation, and all but a handful of the pupils withdrawn by their indignant friends. The fate of the school was clear to all except the council; it has lingered on only to add to the liabilities of the shareholders, who have now met to learn from their directors the history of a great scheme blighted, of insolvency far beyond the value of the mortgaged property, of their ancient school relapsed into the feeble, obsolete, provincial position from which Mr. Tuckwell rescued it.

ON SUPERSATURATION

A SOLUTION is a case of adhesion overcoming cohesion; and when these two forces are in equilibrium the solution is said to be *saturated*.

In general the adhesive force is diminished by lowering the temperature, and a portion of the solid, a salt, for example, is thrown down; but it is increased by raising the temperature, so that the liquid can take up an additional portion of the solid.

In the case of a large number of salts, but for the most part those that are hydrated, a solution saturated at a given high temperature can be reduced to a lower one without depositing any salt, in which case the solution is said to be *supersaturated*, because it contains more salt than it can take up at the reduced temperature.

For example, 100 parts of water at 194° F. will take up 209 parts of potash alum, but at 32° only 4 parts. A boiling solution of alum containing 209 parts of the salt in 100 of water may be reduced, in a covered vessel, to the freezing-point of water without depositing any salt; in such case the water at 32° holds $52\frac{1}{4}$ times more salt in solution than it can take up at that reduced temperature.

The phenomena of supersaturation are, perhaps, best exhibited by means of Glauber's salt, or sodic sulphate, of which there are three forms, namely, the normal salt, containing ten atoms or proportionals of water of crystallisation, the seven-atom salt and the anhydrous. If two or three ounces of the normal salt in one ounce of water be gradually heated in a flask to 93° F., its point of maximum solubility, it will be completely dissolved, but if the heat be applied too suddenly or too fiercely, the anhydrous salt is thrown down, and occasions violent bumpings of the vessel. If the solution be properly conducted, it can be raised to the boiling-point, and so be left to cool (the mouth of the flask being covered) to the temperature of the air, without depositing any salt. It is now supersaturated. If, however, the solution be cooled to about 40° F. and under, the modified seven-watered salt is thrown down, the mother-liquor remaining supersaturated. If the flask be left uncovered, or the solution be touched with a proper nucleus, radiating lines, or rather plates of crystals of the normal salt, diverge from a point on the surface, and proceeding rapidly downwards, seem to interpenetrate the seven-watered salt, destroying its transparency, changing its molecular structure, whereby it assumes the appearance of boiled white of egg, and imparting to it three additional equivalents of water. The solution has now become solid, and the temperature considerably raised in consequence of change of state.

The condition of supersaturation was first noticed by Dr. Black towards the end of the last century, and from that time to the present many scientific men, both of this country and of the Continent of Europe, have studied the subject, often with contradictory results. The phenomena connected with the nuclear action of bodies in producing the sudden crystallisation of these solutions seem to behave differently in the hands of different inquirers; so that the facts affirmed by one writer are denied by another; and the theory which seems to have been disproved by one is again brought forward by another. Thus, to quote only a few of these contradictory statements, Ziz found that air and solids act best as nuclei when dry; if wet, or boiled with the solution or thrown into it while hot and allowed to cool with it, they are inactive: Löwel denies that air has any nuclear action, but that solids exposed to the air become active by a sort of catalytic force, and that alcohol is active: Liversidge and others deny that alcohol is active: Selmi states that dry air is nuclear, and acts by getting rid of water at the surface and producing crystals which continue the action: Gay-Lussac had before expressed a similar opinion: Lieben found that soot, platinum black, and pounded glass are nuclei: Schröder remarks that it is always a matter of chance whether such or such a substance produces crystallisation; Gernez, Viollette, Schiff, and Liversidge are satisfied that there is only one nucleus, and that is a salt of the same kind as the one in solution or isomeric therewith; and that when liquid and solid bodies apparently act as nuclei they are really contaminated with minute particles of the salt which is supposed to be always floating in the air: Jeannel opposes this theory, and Pellogio "gives proofs that the phenomena of supersaturation are not so simple as the French physicists would imply;" he finds that porous bodies act as nuclei: Viollette and Liversidge, on the contrary, find that porous bodies and bodies greedy of water and capable of being hydrated, such as absolute alcohol, fused sulphate of copper, quicklime, &c., are quite inactive.

In the midst of all this conflict of testimony, my own results were not likely to escape censure. Indeed, they have been attacked with a degree of acrimony which seems to be very much out of place in the calm inquiry after scientific truth, and in the presence of so many contradictory results produced by eminent conscientious observers. I was not able for a long time to account for the negative results which were opposed to my positive ones, and I threw the subject aside. At length, however, I was led to suspect that nuclei are powerfully affected by varying atmospheric conditions, whereby they sometimes determine the solidification of these solutions, and at other times not. Accordingly I undertook a series of daily observations which extended over some months, working with a standard solution of sodic sulphate and an essential oil, and the result was that when the wind at Highgate was northerly or easterly, the oil was nuclear, but with a westerly or southerly wind it was inactive. It was obvious, then, that there was some force present in the air which rendered the oil active, which being absent, the same oil remained passive. I succeeded in identifying this force with ozone, and judging that wherever ozone was present, irrespective of the direction of the wind, the oil would become nuclear, I visited several places, notably one by the seaside, and was confirmed in the view I had taken. For example, at Eastbourne a westerly wind produced in the course of ten minutes a deep orange brown stain on ozone test-paper, and oils exposed to its action became singularly active after a few minutes' exposure. Freshly distilled oil of lemons, oil of cajuput, oil of turpentine, &c., were inactive in the house on supersaturated solutions of sodic sulphate and of alum, but by the sea-side far away from the town, with the wind blowing in the direction of the town, or at the end of the pier, 1,012 feet from the shore, with the wind blowing from the sea, the oils were allowed to fall in drops from a dropping tube into a small clean beaker for about three minutes, when they became powerfully active in rendering the solutions solid.

In my first papers on this subject (*Phil. Trans.*, 1868-1871) a nucleus is defined as a body that has a stronger attraction for the salt, or for the water of a solution, than subsists between the salt and the liquid. Examples are given in which oils, fixed and volatile, alcohol, ether, &c., spreading on the surface of the solution, produce a separation of salt, and the rapid solidification of the solution; whereas, if such liquids, instead of spreading, assume a lenticular form, they are inactive, and may, by shaking the flask, be dispersed through the solution in numerous globules without any immediate nuclear action.

Several circumstances favour the action of these liquids as nuclei: (1) Chemically clean flasks and solutions, so as to maintain (2) the surface tension of the solutions as high as possible, in order to spread a drop of oil, &c., into a film; (3) bright and clear weather, with strong evaporative force.

A newly distilled essential oil is inactive, on account of its strong cohesive force, and when a drop of it is dispersed in globules through the solution, each globule retains its surface-tension, whereby it is prevented from coming into contact with, and separating a molecule of the salt held in solution. The action of ozone is an oxidising one, diminishing the cohesive force among the particles of the oil, just as rust weakens the cohesive force of a bar of iron.

The effect which ozone produces quickly on a newly distilled volatile oil, is produced slowly on the same oil by long keeping. Its cohesive force is so far weakened, that a drop of it on the surface of the solution no longer tends to assume the lenticular form, or to disperse in globules through the solution. Then, as oil can adhere much more strongly to salt than to water, and the supersaturated solution being a highly charged system capable of yielding to a force that is exerted in the right direction, such an oil adheres to and separates a molecule of the salt, and the action once begun is rapidly propagated, until the whole solution is solid.

In like manner newly refined fixed oils may have their cohesive force degraded by various chemical means, as by being treated with an alkali, or with nitric acid, &c., in which condition they are commonly nuclear. Solid and semi-solid fats, such as suet, dripping, lard, butter, fat of meat, &c., act powerfully as nuclei. The freshly cut surface acts most effectually, and, in some cases, a fat cut in one direction may not act for hours, while if cut in another direction it may act immediately. A glass rod smeared with lard, &c., may act better than a small lump of the material.

Several observers, who deny that the oils, &c., have any nuclear action, so contrived their experiments as to expose the oils, &c., to the action of heat, while carefully excluding the outer air. The effect of such manipulation is to increase the cohesive force of the bodies in question; and as they fail to act under such conditions, it was denied that they ever acted at all under other conditions, except when contaminated with particles of the salt more or less ultra-microscopic.

So also in testing the nuclear action of porous and dehydrating bodies, heat is employed, and this destroys the very activity which is about to be tested. Freshly ignited quicklime, for example, is inclosed in thin glass bulbs, sealed, heated to redness, and dropped into the supersaturated solutions. When cold, the bulb is broken, and the contents set free, but in no case with any result.

I have found that porous bodies, such as pumice, plaster of Paris, &c., may be rendered inactive by being treated for about ten minutes in a test tube plunged into boiling water. But when such bodies are thrown into the solutions without any separation of salt, it is not that exposure to heat has rendered them less active as nuclei; they have become in fact more active than before, for they now absorb the solution as a whole instead of its water only; whereas, if after being heated, these porous bodies are exposed to the outer air during ten minutes, they take in a little moisture which tames down their absorptive power, so that when placed in the solution they act more slowly, absorbing water and thereby producing a separation of salt and the solidification of the solution. Absolute alcohol acts in a similar manner. Crumb of bread is a very good porous nucleus.

As to the condition of sodic sulphate in solution there are many reasons for supposing that it is the anhydrous salt; that is, the normal salt gives up the whole of its water of crystallisation to the solution. When by a reduction of temperature a portion of the salt is separated, it combines with seven atoms of water, and this is not nuclear. So also when nuclei fail to effect the solidification of the solution, they cannot be said to be inactive, since they act within certain limits of temperature by throwing down the modified salt. But when nuclei are active in determining solidification they form a kind of *point d'appui*, which enables the disengaged molecule to combine with ten atoms of water, and this is nuclear to the rest of the solution and determines its solidification.

The state of supersaturation is dependent to a considerable extent on the adhesion of the solution to the walls of the vessel. If a portion of this be detached by rubbing or scratching the side below the surface with a strong clean wire the whole system breaks down and the solution immediately becomes solid. If the vessel, such as a test tube, be lined with resin, amber, or some substance to which the solution has a weaker adhesion, it generally becomes solid in cooling. Or if a highly supersaturated solution be poured boiling hot into a shallow vessel, in which the surface of adhesion and the free surface are nearly equal, the solution relieves itself by throwing down a considerable quantity of the modified salt, at temperatures above that at which it is usually formed in narrower and deeper vessels.

I have thus very briefly stated the results of my researches on this difficult subject, and submit them to the candid judgment of fellow-labourers in the same field.

C. TOMLINSON

OUR ASTRONOMICAL COLUMN

VENUS IN THE PLEIADES.—A thousand years ago and later the geocentric track of the planet Venus was occasionally such as to cause it to traverse the Pleiades, a phenomenon which, in these telescopic days, would be one of no small interest to the observer; prior to the invention of the telescope its effect would be merely to obliterate in a great measure, for the time being, the stars forming this group, particularly when the planet happened to be upon them near an epoch of greatest brilliancy. Amongst the observations collected from the Chinese annals and forwarded to Europe in the middle of the last century by the French Jesuit, Gaubil, we find one made under the dynasty *Tang*, in the fifth year of the period *Hwuy-Chang*, on the day *Jin-Woo*, of the second moon —corresponding in the Julian Calender to A.D. 845, March 16—when "Venus eclipsed the Pleiades;" the observation appears to have been made at *Si-gan-fou*, where the *Tang* dynasty had their court, and where the earliest occultation of a star or planet by the moon, that of Mars B.C. 69, February 14, was also observed. If we found an examination of this "eclipse" of the Pleiades by Venus, upon Leverrier's data, using them with a sufficient degree of approximation for the purpose in view, it appears that at dusk at *Si-gan-fou*, on March 16, 845, Venus was situate near the star *Electra*, not far from the parallel of the principal star of the group *Alcyone*, but three-quarters of a degree to the west of it, and that about the same time on the evening of March 17, after having passed close to *Maia*, the planet would be in the same right ascension as *Alcyone*, about twenty-four minutes to the north. Although the so-called eclipse of the Pleiades might commence therefore on March 16 as the Chinese record, Venus would be more centrally upon the group on March 17, according to our modern tables. Her apparent diameter was then thirty seconds, and she would shine with more than average brilliancy. Another eclipse of the Pleiades is mentioned under the later *Sung* dynasty, on March 10, A.D. 1002.

VARRO'S STORY OF THE ANOMALOUS TRACK AND FIGURE OF VENUS.—In a *résumé* of the recent progress of astronomy contributed to an American work by Prof. Holden, of Washington, we note a reference to a communication made by M. Boutigny to the Academy of Sciences at Paris in December, 1877, calling attention to a passage in Varro, which describes the planet Venus, as having about the year B.C. 1831 (not B.C. 31, as misprinted in Prof. Holden's Report) "changed its diameter, colour, figure, and course." M. Boutigny had probably overlooked the circumstance that this story of Varro's had been brought into notice long before, in a French work of astronomical authority, the "Cometographie" of Pingré, who, believing that the fable was originated by some celestial phenomenon, considered it was most probably due to the appearance of a bright comet. Pingré thus gives the fragment, preserved by St. Augustin:—"There was seen, says Varro, a surprising prodigy in the heavens, with regard to the brilliant star Venus, which Plautus and Homer call, each in his own language—the evening star. Castor affirms that this fine star changed its colour, size, figure, and track, which had never occurred before, and which has not occurred since. Adrastus, of Cyzicus, and Dion the Neapolitan, refer this great prodigy to the reign of Ogyges." Pingré's explanation will be found in "Cometographie," t. i. p. 247; the epoch he assigns for the phenomenon is "vers 1770."

The story has no astronomical importance, and is only noticed here from its revival so recently, as mentioned above.